GLAST Portable Spacecraft Simulator (PSS) Requirements

Final

March 16, 2004

GLAST PSS Requirements table

Development Effort:

#	Capability	Release	Comment/Assumption
	System Level		
1	Support Ethernet TCP/IP (10Base-T) interface simulating the SN or GN ground station to MOC interface for telemetry and command. Simulate SN ground station data formats (WSC) and backup ground station ground data formats (GN Wallops, USN).	1	Just need to do wrapper/stripper for ground station headers. No effort for IP interface.
2	Provide offline utility to translate GLAST project database file into internal PSS telemetry data base format.	1	Already done for SWIFT telemetry files. Will need to be done for command data to support command recognition, verification, scenario triggering.
3	Support RS-422 and ECL serial interface compatible with the Engineering Design Team (EDT) card) for transmitting telemetry (40 Mbps, 2.5 Mbps, 155 kbps real time, 1,2,4,8 kbps).	2	Developing module(s) for the Ku-band data rate will have a cost impact. Existing hardware does not support 40 Mbps.
4	Support RS-422 and ECL serial interface for receiving command stream @ .25, 2, 4 kbps	2	Some testing will be involved to make sure no interference with the telemetry.
5	Provide basic GUI capabilities such as save/restore, event logs, and scenario file execution.	1	Assume a no cost item unless specific requirements are levied.
	Telemetry		
6	Simulate spacecraft time using mission elapsed time and update time in telemetry data. Be capable of leap second rollover.	1	Use PC system time. GLAST-specific format needed. If format is similar to SWIFT, cost will be minimal.
7	Support TDRSS interface and frame format	1	SIMSS supports
8	Provide user with capability to modify telemetry mnemonics individually in real time and to associate a function for updates over time.	1	This capability is already in SIMSS. Applying a function is only provided by scenario.
9	Playback recorded data (i.e., from CD or hard disk) without any modification to update telemetry headers, time fields, CLCW, and RS encoding.	2	Strictly playback of prerecorded data. This is instead of simulator-generated telemetry. This capability exists in SIMSS TxFile module. However, some adjustments need to be made to maintain the 40 Mbps rate.
10	Support 2 separate physical telemetry (CADU) streams simultaneously. These streams are described in following 3 sections.	1	SWIFT PSS provided ability to add or remove virtual channels to 1 stream. From what I heard, GLAST will have 2 separate GN links at the same time. Figuring out a reasonable way to do this will take some effort.

#	Capability	Release	Comment/Assumption
11	40 Mbps Ku-band science data SSR dump. Will contain variable length telemetry packets up to 64K packed in CADUs using 1 VCID. Support the following VCIDs: VC0 GN/SN Real-time Telemetry VC1 GN/SN Alert and Diagnostic Telemetry VC2 GN/SN Stored Observatory Housekeeping and Diagnostic Data from RAM VC3 GN/SN Stored Observatory Housekeeping and Diagnostic Data from SSR VC8 SN Stored Ku-band LAT Instrument Science VC9 SN Stored Ku-band GBM Instrument Science VC 63 GN/SN Fill Frames	2	Packets will contain LAT and GBM APIDs. Packet data contents are configurable (i.e., user can set telemetry points at set packet locations based on PDB). Packets might need to be generated and logged prior to test and transmitted via TxFile. Packet generation capability exists, but some cost possible due to packet size and xmit rate. *NOTE that there is still the issue(how this will be implemented) of how the packets will be separated/mixed on SSR (i.e., sync marker).*
12	2.5 Mbps S-band GN mode diagnostic data SSR dump. Support the following VCIDs: VC0 GN/SN Real-time Telemetry VC1 GN/SN Alert and Diagnostic Telemetry VC2 GN/SN Stored Observatory Housekeeping and Diagnostic Data from RAM VC3 GN/SN Stored Observatory Housekeeping and Diagnostic Data from SSR VC 63 GN/SN Fill Frames	1	Assuming separate physical channel, one VCID, multiple APIDs. Packet contents are configurable. Given the data rate, will we also be generating this data prior to a test and using TxFile for playback.
13	Low rate S-band Multiple Access Real Time data or 1 Kbps S-band Burst Alert data. Support the following VCIDs: VC0 GN/SN Real-time Telemetry VC1 GN/SN Alert and Diagnostic Telemetry VC2 GN/SN Stored Observatory Housekeeping and Diagnostic Data from RAM VC3 GN/SN Stored Observatory Housekeeping and Diagnostic Data from SSR VC11 SN Observatory Alerts (via S-band TDRS MA and DAS) VC 63 GN/SN Fill Frames	1	Assuming separate physical channel, one VCID, multiple APIDs. Packet contents are configurable. This is how the PSS normally generates telemetry.
	Command		
14	Log command data	1	Already exists in SIMSS
15	Receive and validate Transfer Frames from 2-Kbps stream of GLAST CLTUs	1	A SIMSS generic capability. Assume minimal cost for testing if no specific requirements are levied.

#	Capability	Release	Comment/Assumption
16	Support COP-1 processing, including CLCW next-expected-sequence (NES) counter, CLCW lockout flag based on exceeding sliding window, and CLCW retransmit flag based on missing command sequence numbers. Receive and simulate processing of CCSDS “unlock” and “set” control commands and update CLCW in telemetry accordingly. Receive and simulate processing of CCSDS commands in bypass mode and increment FARMB counter in CLCW accordingly	1	Already done for SWIFT. There should be minimal cost to GLAST.
17	Implement command recognition based on the PDB.	1	This has been done for other missions but level of effort will depend on how much code can be reused. This must be implemented first if command scenario triggering or command verification is desired.
18	Implement command-receipt verification in telemetry based on the PDB.	1	This has also been done for other missions but cost will depend on GLAST-specific changes required.
19	Implement scenario triggering based on command recognition.	1	Same as command verification.
	Other		
20	User’s Guide		Similar effort as SWIFT for style and content unless FOT requests something different.
21	High-level requirements analysis & system design, system engineering, and project support.		Support project meetings and review documentation that has impact on simulator functionality
22	SUBTOTAL – Implementation effort		
23	System testing		

4. Schedule Estimate:

Delivery Schedule:

Need to verify feasibility of following schedule.

Release	Desired Date	Desired Contents
Release 1	10/15/04	RT functions; burst messages & TDRS (can be deferred to R2 if necessary); TCP/IP
Release 2	10/15/04	Serial ECL interface for Ku-band front-end testing. Note: this is based on schedule for SOC testing (Howard Dew).
Release 3	11/30/04	Error corrections, minor enhancements

6. Assumptions:

a. Assume that the PSS will need to support the 40 Mbps Ku-band and low rate S-Band MA DAS output simultaneously, otherwise, S-band SSA or MA is mutually exclusive from Ku-band data.
b. TDRS (SN mode) and GN mode will be mutually exclusive.
c. Any medium fidelity modeling will be performed by scenario files. An estimate for medium fidelity models is not included.
d. Assume the PSS will be used for ground station interface testing. A minimum of Wallops and one Universal Space Network (USN) site.

7. Questions:

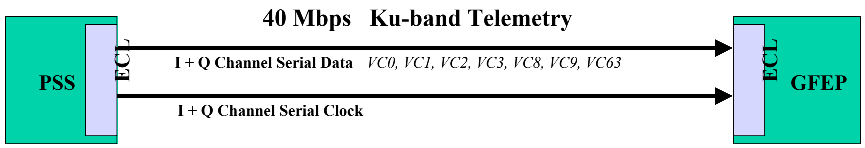
a. Will all GN CADUs be the same size? We thought that we heard 1K at the meeting.
b. I-channel can be 32 kbps RT data **or** 1 kbps Burst Alert data. Can we assume that the PSS would do this by enabling/disabling APIDs, adjusting their intervals, and controlling thru-put via Serial module?
c. Does the PSS have to generate segmented telemetry packets?
d. What floating point format does GLAST require? SWIFT used IEEE-754. Since Visual C++ was consistent with this format, real floating point values could be inserted in telemetry packets very easily. If GLAST supports the same format, there should be no additional cost otherwise there some effort would be required.

Response to GLAST Unique Requirements:

- **Provide serial interface that simulates Ku-band 40 Mbps telemetry stream** – the PSS shall provide the capability to transmit a 40 Mbps telemetry stream. Different hardware will have to be used due to the increased rate. Some I/O cards in this range could handle the actual speed. However, they usually do not perform the encoding required (RS, PN, convolutional, randomization, etc.). To satisfy this requirement, we would like the option of building the dumps (contents configurable by the user) before transmission so that the encoding can be performed. This option was presented and verbally approved by Mike Rackley when an initial set of PSS requirements was drafted. There will be a some prototyping effort involved to determine the best way to handle this requirement.
- **Handle GLAST VC allocation and method for how these VC's are transmitted in the physical data stream** – the PSS shall provide the capability to simulate the VC allocation in the real-time and SSR dumps. Once the algorithms are known, the PSS will allow the user to enable/disable the insertion of specific VCs in the telemetry streams. Basically, the contents of the telemetry streams shall be configurable by the user. This type of user functionality has been implemented before on other SOC-provided simulators.
- **Ingest instrument CCSDS packets and commutate into valid observatory CCSDS frames** – the PSS shall have the capability to interface with an external source to ingest instrument packets and merge these packets in the telemetry stream. These packets could also be merged from a pre-recorded file (the most likely format). There will be some data manipulation/adjustment in regard to the packet commutation. This type of functionality has been performed by the SIMSS group for various projects. Most recently with the ETSF for Aqua/Aura.
- **Attach sync marker to each instrument science packet** – the PSS shall precede each instrument packet in the real-time telemetry stream and data logging functions with a sync (TBD). This capability is already available in a SIMSS generic module. However, it might have to be implemented in a GLAST specific module.
- **Simulate burst alert telemetry, details TBD** – the PSS shall have the capability to transmit "burst alert telemetry" in a manner that is not much different than Swift. Some TBD minor adjustments might have to be performed when transporting the Swift code.
- **Simulate diagnostic data, details TBD** – the PSS shall have the capability to provide multiple VCs in a telemetry stream. This will include VCs that contain the diagnostic data. The fidelity of the data content is TBD at this point. However, adding fidelity other than fill data is not a significant effort.
- **Provide physically portable PSS system as well as PSS software (that can run on a MOC workstation)** – at least two separate systems will be provided and an initial ROM will include an estimated cost for hardware based on known values.

PSS Data Flow Diagrams

GLAST PSS Data Flow Diagram For GFEP Stand-Alone Testing



TELEMETRY DEFINITIONS:

Ku-band data (as if generated by WSC) **4.3 Mbps VC8, VC9, VC63**
155 kbps VC0, VC1, VC2, VC3, VC63

VC0 = GN/SN Real-time Telemetry
VC1 = GN/SN Alert and Diagnostic Telemetry
VC2 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From RAM
VC3 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From SSR
VC8 = SN Stored Ku-band LAT Instrument Science Data
VC9 = SN Stored Ku-band GBM Instrument Science Data
VC10 = SN Observatory Housekeeping (TDRS SSA S-band)
VC11 = Observatory Alerts (TDRS SMA S-band including DAS)
VC63 = GN/SN Fill Frames

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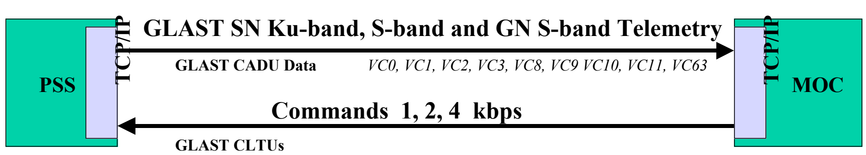
GLAST PSS Data Flow Diagram For MOC Testing



TELEMETRY DEFINITIONS:

Ku-band data (as if generated by GFEP at WSC) **4.3 Mbps VC8, VC9, VC63**
155 kbps VC0, VC1, VC2, VC3, VC63

S-band data (as if generated by WSC Legacy Systems) **1,2,4,8 kbps VC0, VC1, VC2, VC10, VC11, VC63**

S-band data (as if generated by Wallops or USN) **2.3 Mbps VC2, VC3, VC63**
155 kbps VC0, VC1, VC11, VC63

VC0 = GN/SN Real-time Telemetry
VC1 = GN/SN Alert and Diagnostic Telemetry
VC2 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From RAM
VC3 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From SSR
VC8 = SN Stored Ku-band LAT Instrument Science Data
VC9 = SN Stored Ku-band GBM Instrument Science Data
VC10 = SN Observatory Housekeeping (TDRS SSA S-band)
VC11 = Observatory Alerts (TDRS SMA S-band including DAS)
VC63 = GN/SN Fill Frames

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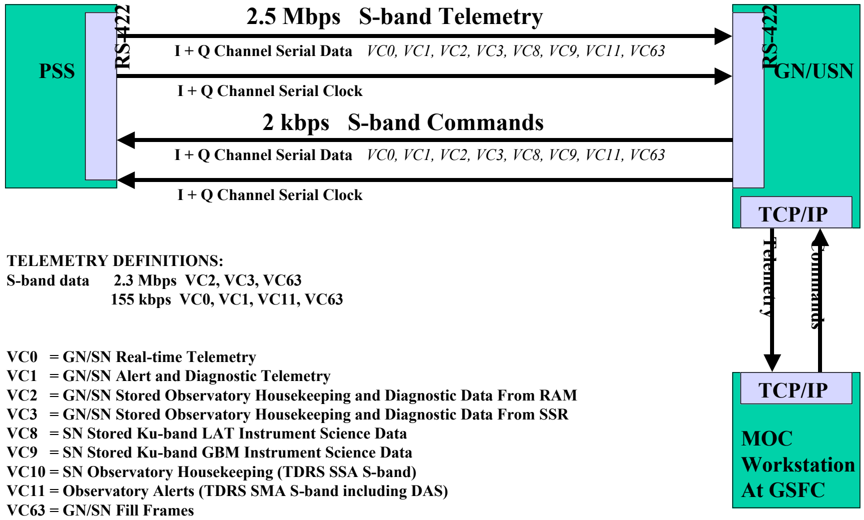
PSS Data Flow Diagram For GN/USN Testing

NOTE This data flow may be simulated by sending files to the respective ground stations.



TELEMETRY DEFINITIONS:
S-band data 2.3 Mbps VC2, VC3, VC63
155 kbps VC0, VC1, VC11, VC63

VC0 = GN/SN Real-time Telemetry
VC1 = GN/SN Alert and Diagnostic Telemetry
VC2 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From RAM
VC3 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From SSR
VC8 = SN Stored Ku-band LAT Instrument Science Data
VC9 = SN Stored Ku-band GBM Instrument Science Data
VC10 = SN Observatory Housekeeping (TDRS SSA S-band)
VC11 = Observatory Alerts (TDRS SMA S-band including DAS)
VC63 = GN/SN Fill Frames

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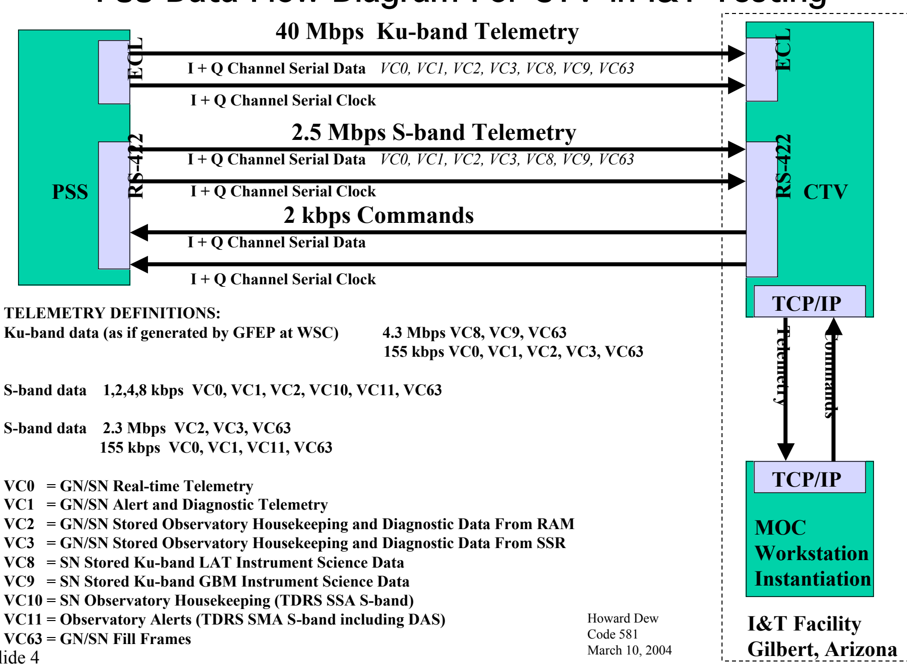
PSS Data Flow Diagram For CTV in I&T Testing



TELEMETRY DEFINITIONS:
Ku-band data (as if generated by GFEP at WSC) 4.3 Mbps VC8, VC9, VC63
155 kbps VC0, VC1, VC2, VC3, VC63

S-band data 1,2,4,8 kbps VC0, VC1, VC2, VC10, VC11, VC63

S-band data 2.3 Mbps VC2, VC3, VC63
155 kbps VC0, VC1, VC11, VC63

VC0 = GN/SN Real-time Telemetry
VC1 = GN/SN Alert and Diagnostic Telemetry
VC2 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From RAM
VC3 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From SSR
VC8 = SN Stored Ku-band LAT Instrument Science Data
VC9 = SN Stored Ku-band GBM Instrument Science Data
VC10 = SN Observatory Housekeeping (TDRS SSA S-band)
VC11 = Observatory Alerts (TDRS SMA S-band including DAS)
VC63 = GN/SN Fill Frames

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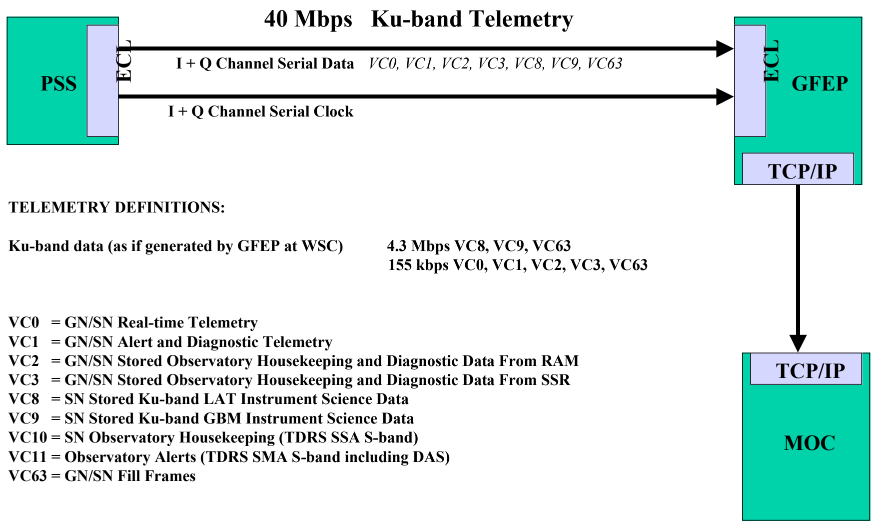
PSS Data Flow Diagram For WSC/GFEP Testing



TELEMETRY DEFINITIONS:

Ku-band data (as if generated by GFEP at WSC) **4.3 Mbps VC8, VC9, VC63**
155 kbps VC0, VC1, VC2, VC3, VC63

VC0 = GN/SN Real-time Telemetry
VC1 = GN/SN Alert and Diagnostic Telemetry
VC2 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From RAM
VC3 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From SSR
VC8 = SN Stored Ku-band LAT Instrument Science Data
VC9 = SN Stored Ku-band GBM Instrument Science Data
VC10 = SN Observatory Housekeeping (TDRS SSA S-band)
VC11 = Observatory Alerts (TDRS SMA S-band including DAS)
VC63 = GN/SN Fill Frames

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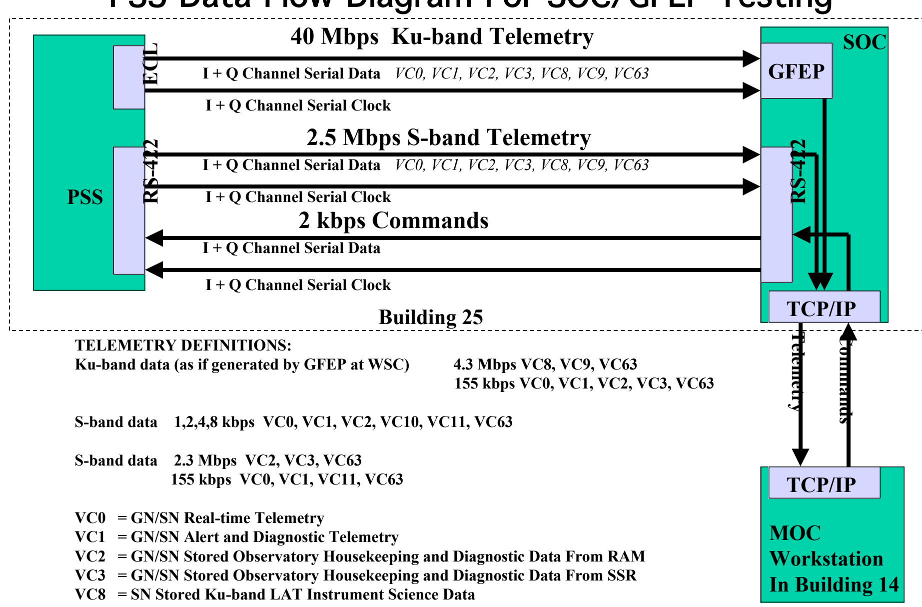
PSS Data Flow Diagram For SOC/GFEP Testing



TELEMETRY DEFINITIONS:
Ku-band data (as if generated by GFEP at WSC) **4.3 Mbps VC8, VC9, VC63**
155 kbps VC0, VC1, VC2, VC3, VC63

S-band data 1,2,4,8 kbps VC0, VC1, VC2, VC10, VC11, VC63

S-band data 2.3 Mbps VC2, VC3, VC63
155 kbps VC0, VC1, VC11, VC63

VC0 = GN/SN Real-time Telemetry
VC1 = GN/SN Alert and Diagnostic Telemetry
VC2 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From RAM
VC3 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From SSR
VC8 = SN Stored Ku-band LAT Instrument Science Data
VC9 = SN Stored Ku-band GBM Instrument Science Data
VC10 = SN Observatory Housekeeping (TDRS SSA S-band)
VC11 = Observatory Alerts (TDRS SMA S-band including DAS)
VC63 = GN/SN Fill Frames

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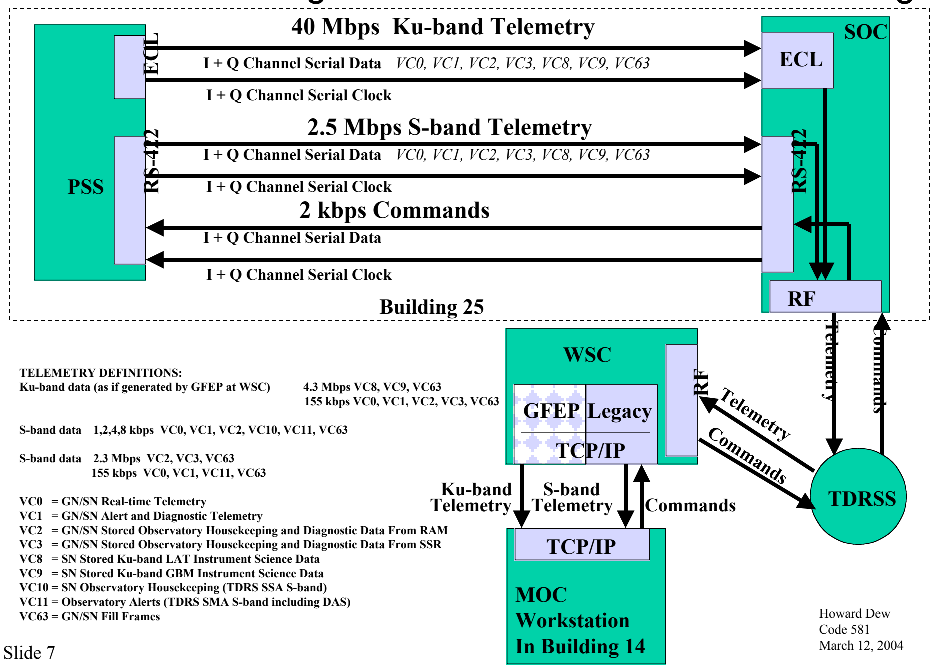
PSS Data Flow Diagram For End-to-End SOC/WSC Testing



TELEMETRY DEFINITIONS:

Ku-band data (as if generated by GFEP at WSC) **4.3 Mbps VC8, VC9, VC63**
155 kbps VC0, VC1, VC2, VC3, VC63

S-band data 1,2,4,8 kbps VC0, VC1, VC2, VC10, VC11, VC63

S-band data 2.3 Mbps VC2, VC3, VC63
155 kbps VC0, VC1, VC11, VC63

VC0 = GN/SN Real-time Telemetry
VC1 = GN/SN Alert and Diagnostic Telemetry
VC2 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From RAM
VC3 = GN/SN Stored Observatory Housekeeping and Diagnostic Data From SSR
VC8 = SN Stored Ku-band LAT Instrument Science Data
VC9 = SN Stored Ku-band GBM Instrument Science Data
VC10 = SN Observatory Housekeeping (TDRS SSA S-band)
VC11 = Observatory Alerts (TDRS SMA S-band including DAS)
VC63 = GN/SN Fill Frames

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